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SOME SPECIAL FORMS OF HALOS*.

BY A. F. HUNTER.

WHAT I propose to do is to make a selection from my notes of past years on some of the rarer examples I have seen of the optical phenomena of the atmosphere, and to explain each example that I select. It has not been my practice to note every halo I saw; that would be useful only in an observatory for a complete census of them. I noted only rare and interesting forms, and this paper will be a selection from that selection, giving some of the rarest forms.

The halo, as usually figured in the textbook, has a composite nature, consisting of six or seven parts, and is really a group of several halos formed in ways different from each other.

Halos are produced by thin sheets of snow crystals in the higher parts of the air. A familiar picture of snow crystals shows:—

1. The constant angle which the crystals always have, viz., 60°. No difference whether the crystal be large or small, its

*The introductory part of a paper on "Halos," read at the Meeting of the Society in Toronto, November 6, 1917, the remaining portion, viz., on "Distorted Solar Halos," having been published in this JOURNAL for January, 1918.

angles are always the same (60°). This is the chief peculiarity of the hexagonal system of crystallization, and there are other substances, such as calc spar, which crystallize in this system, besides common ice and snow. The picture also shows:—

2. When broken into pieces, the minute fragments have smooth faces, from which reflexions can take place, and the pieces also have axes of unequal length; in other words, the fragments are very small prisms of ice.

These small prisms, spread thinly in wide sheets in the higher air, as they often are, make halos of reflexion, and also halos of refraction, which sometimes all appear together in the combined form shown in the ordinary textbook figures, but the parts of which have really nothing whatever to do with each other, being formed in the two different ways. The halos of refraction result from the combination of rays of light refracted to the same extent through the small prisms with the same angle (60°), all refracting the same amount whatever their sizes may be. And the halos of reflexion result from the combination of small images of the sun or moon all reflected off the faces of the small prisms. Our work in this paper will chiefly amount to an analysis of the combination halo into its different parts.

When the light of the sun or the moon is refracted through fog, i.e., through small particles of water, instead of through snow particles, the optical effect is entirely different from what we see through the snow crystals. Through fog the sun's light or the moon's light makes what is known as the corona, which is likewise a spectrum, circular, but much wider, and also closer to the orb than the one that results from snow crystals. One often sees a corona around an electric street light at night, especially in damp weather.

In the higher parts of the air there can be only the finest snow dust, the larger snowflakes being confined to the lower air. We see this fine snow dust in the cores of hailstones when broken open by a hammer, and in the fine snow drifted into wooden buildings through small crevices that will not admit the larger snowflakes; and also in the blizzards that occur in the dry climate of

the Canadian northwest provinces, and on the highest parts of lofty mountains.

The cause of the production of halos by means of snow crystals was known as long ago as the time of Newton, who wrote on this subject, and it was perhaps known for a longer time. The one who gave the most stimulus to the subject in modern times was Auguste Bravais, a French scientist who wrote about two-thirds of a century ago. It was Bravais, for example, who first pointed out that "mock suns" are due to refraction through crystals all having their longer axes vertical (a view that has been generally adopted by scientists), and he enunciated several other fundamental principles in the theory of halos, now generally accepted.

As an example of how the formation of the halo takes place, we may select the case of the ordinary sun circle at 22°. A snow crystal near the line from the sun to the observer sends out a spectrum of its own size, another sends out another spectrum, and so on, until the entire circle is built up. The eye of the observer, looking at the snow crystals in the minimum position, catches only those spectra that pass in his direction, although all other snow crystals in the air having the proper position are refracting each a spectrum in some direction at the same time.

The snowline in this latitude in midsummer is 9,000 or 10,000 feet, about two miles or three kilometres, so that in the very hottest weather of summer we are never more than two miles distant from snow at any time.

It is important to realize rightly in what stratum of the air halos usually occur; they are in the region above the clouds, as a rule, viz., in what has been called the "stratosphere," doubtless because of the diffuse condition of its cloud matter. This stratum is the cirrus haze above all the forms of definite clouds that we know. The haze occurs in the lower parts of the stratosphere, and probably also extends far up into it, at certain times.

The thinness of the haze-film or sheet determines the visibility of the halo. If the haze is too thick, there is no optical effect. The play of colors in the soap bubble and in thin crystals occurs

only when they have a thinness commensurate with the light waves, and a similar state of things exists with the halo conditions. In summer time when the snowline is high, say two miles high, the snow-crystal-film of the higher air is thinner than in winter time, and the circular halo then often has the rainbow colors; but in winter this is rare because the snow film is usually too thick to give the pure spectrum colors, there being then too much overlapping of the colors, with the result of making white halos, or nearly so. When there is a moderate amount of overlapping of colors, only the edges of the halos show color.

The cirrus haze of the stratosphere is subject to the action of electro-magnetic forces, and the repulsion of similarly electrified particles of snow amongst themselves may also account for the very diffuse condition of the cirrus haze and for the cloud-wisps, which also produce halos.

Electro-magnetic forces are especially present in "mock suns," and in sun pillars and other halos of reflexion. Some electrification of the particles of snow dust must occur.

I have seen the statement in print that the halos are linked with the sunspot phenomena. Dr. Besson, in an article on halos in the U.S. Monthly Weather Review (Washington) for July, 1914, p. 437, alludes to this connection in the following words:— "The annual number of days with halo seems to show a variation that is either parallel with or inversely as the variation in sunspots." It is also obvious that they are numerous when auroras are numerous.

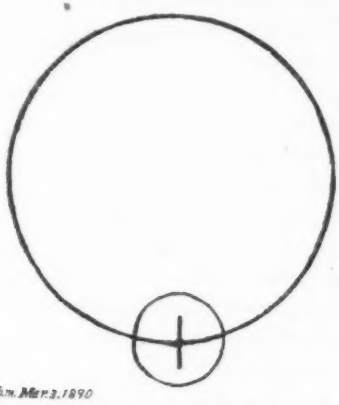
Finally, a halo is often in the forepart of a cyclone, and thus serves as a warning or signal of the coming storm. For many ages this has been cherished in weather lore as a sign of a future storm, and it is often a good sign, but not always so.

The foregoing general remarks on halos may help us to understand the particular cases we will now take up, in their order of time, most of which were observed by the writer at Barrie, Ont.

Great White Horizontal Circles. On March 3rd, 1890, at 7.30 p.m., there was an unusual halo of the moon at Barrie. A

great white circle passed through the moon's disk and extended horizontally around the sky. This circle, of the same breadth and altitude as the moon, was exceedingly well-defined, being complete around the entire sky, and the centre of it was the zenith. The ordinary first circle was faintly visible at the same time, and also an upright or vertical shaft of light was faintly visible, having the same diameter as the moon's disk and passing through it. There were three features of the great circle of this halo that I noted particularly, viz.:—

1. It was perfectly horizontal.
2. It was white, or rather the color of the moon itself.
3. While so extensive, and the band of light as wide as the moon, it was uniformly bright around the entire sky.



HALO OF THE MOON OBSERVED AT BARRIE, ONT., MARCH 3, 1890
The large horizontal circle had the zenith for its centre.

The air had a foggy appearance, and there was a slight fall of fine snow at the time, but not thick enough to obscure the moon or the halo. White circles like this must arise from exterior reflexions from the flat faces of the crystals, as there would be spectrum colors, at least on the edges, if there was any refraction of the light through them. We may regard the small snow crystals as small mirrors or looking glasses all hanging in one position in

the air, or rather, gently falling through it. The reflexions of the image of the moon off their faces all combined together gave the halo, which, speaking literally and truthfully, was an enormous halo around the observer's own head, and like the similar case of the rainbow where everyone sees his own rainbow, each observer, in a strangely human way, would see this vast evidence of his own canonization and not the other person's.

The white cross-bars through the moon, made by such external surface reflexion, was a common form of halo the same winter, the snow particles forming it always appearing to be in the lower air; whether they actually were or not, I cannot say.

"Mock-suns," made by refraction through crystals in the vertical position, as Bravais pointed out, and "sun-pillars," i.e., the upright white solar shafts of light made by reflexions of the sun's image off the surfaces of crystals that are in the horizontal position, visible after as well as before sunrise or sunset, were also both common forms during the same winter of 1890.

Some years later, when reading the Narrative of the polar expedition of Capt. (afterward Sir) Francis Leopold M'Clintock, who solved the fate of Sir John Franklin in the Arctic regions, and who received the reward offered for the desired information, I found a description of a halo similar to the one I am describing, and I can commend his account of it for brevity and for pointed description, to anyone seeking to increase our knowledge of these phenomena.

From "In the Arctic Seas," by Capt. M'Clintock, R.N., p. 68:

"One of those strange lunar phenomena which are but seldom seen even here (Baffin Bay, N. Lat. 74½ deg., Long. 70 deg. W., i.e., off the N. end of Baffin Land), a complete *halo encircling the moon*, through which passed *a horizontal band of pale light that encompassed the heavens;* above the moon appeared the segments of two other halos, and there were also mock moons or paraselenæ to the number of six. The *misty atmosphere* lent a very ghastly hue to this singular display, which lasted for rather more than an hour."

In the halo I observed on March 3, 1890, I noted especially

those features I have italicized in Capt. M'Clintock's description.

Solar Parhelic Circles. On April 25th, 1898, at 6.30 p.m., I observed a halo of the sun having a partial horizontal circle. The white band through the orb was well defined for some distance on both sides of the sun. At the same time the first and the second circles were both well defined, and the "mock-suns" and the upper arc, tangent to the first circle, were also bright, but those of the second circle were not noticeable.

On March 5th, 1902, I observed another great circle through the sun, which I saw at 11 a.m. and at 11.15 a.m., but it was not visible at 12 noon. The first and the second circles of the halo had been visible as early as 9.30 a.m., but the second circle was not very distinct by 11 o'clock when the great circle became visible. The "mock-suns" at the first circle were not strong; but on the great circle, which was white, knots were visible at intervals, not more than four altogether, though perhaps five if we count the "anti-sun." The two primary "mock-suns" would make seven. This example of the parhelic circle appears from my notes made at the time of its appearance to have been complete, but it did not impress me so much by its brightness as that of the moon twelve years before.

Again, on April 7, 1917, the well developed halo of the moon that attracted so much attention over a portion of Ontario had a partial circle of this kind at the writer's place of observation (Barrie), but the horizontal band did not extend far beyond the second circle.

Thus, of four horizontal circles seen in 28 years, viz., two of the sun and two of the moon, only two were complete. This shows that instances of the kind are not very common, although other observers may have noted more during the same period.

Colored Arcs in the Zenith. It was while observing a halo of the sun on May 14, 1898, that I first saw a close connection between two "mock-suns" and the colored arc in the zenith, or as it is usually called,—the upper tangent arc to the second circle,—though it does not appear to have any connection with that circle.

and occurs simultaneously with it only on some rare occasions. At 5.50 p.m. both "mock-suns" and arc were visible. The brilliancy of the arc varied from minute to minute, and it lasted altogether for 15 minutes. When one "mock-sun" flared bright, the opposite arm of the arc became also bright, and *vice versa*. Having observed on that occasion the close alliance between these two parts of halos, it then became my practice to look for an arc when "mock-suns" appear, and in this way I have more frequently observed them than I could otherwise have done, though they do not always appear together. During the twenty years that have elapsed I have observed altogether about a dozen arcs, some bright, others feeble. One which I saw at 8.50 a.m. on March 3, 1917, was intensely bright, and in addition to the arc there were at times faint cross-bars, of which the sun was at the intersection. The frosty air at the time was foggy or hazy. Within the concavity of the arc was a fluorescence of the ultra-violet rays.

Sun Pillars. On Feb. 17, 1899, I observed a perpendicular shaft of light or sun pillar rising from the sun, which was shining dimly through a thick stratum of haze. The parts of the pillar fluctuated in brightness like the streamers of an aurora, and at about the same rate. It appeared to be evident from this fluctuating example of halo that there is a resemblance between halos and auroras in their formation. The drift of the streamers in the aurora are probably due to motion of the snow dust in the very highest part of the atmosphere, the same substance that visualizes halos. This halo in 1899 first brought to my attention the probable intimate connection between halos and the electro-magnetic forces in the higher parts of the atmosphere, and since then I have been able to pursue the subject with more advantage.

The altitude of at least some sun pillars would seem to be very great, as one indicated that I saw on March 7, 1912, at 6.50 a.m., just before sunrise. A shaft of strong light rose from the horizon, showing where the sun might be expected to rise, and in addition to being intense, it was crimson-colored, having the same tint as the clouds have at that time when the sun's rays are

diffracted. The sun itself appeared above the horizon about twenty minutes later. I can imagine a primitive people, seeing a flaming sword like this rising out of the horizon, would think that the last day had come. In fact, many myths have had their origin in such appearances, and nature myths have now come to be studied with more profit than formerly. An interesting paper on this subject alone could be written.

Conclusions. It may have already become evident to those who have followed closely the explanations of the different forms of halos thus far, that there are two positions in which the longer axes of the snow crystals commonly lie. We have found:—

1. Some with the prisms vertical.
2. Others with the prisms horizontal.

These two directions may even exist simultaneously, and it is in this way the cross-bars are formed in halos of reflexion, and the "mock-suns" and tangents in halos of refraction. It will be recalled that auroras adopt the same two directions, viz., the vertical streamers and the horizontal bands. We thus find a close parallel between the two classes of phenomena,—auroras and halos. The halos show us the electro-magnetic condition of the higher parts of the air at times when the light of the sun or the moon makes it impossible to see any aurora if it should be present. In other words, we are getting the same information, whether the sun or the moon is shining, or whether it is absent, and the two periods are the complements of each other and make the record almost continuous if we could always see the clear sky.*

*On the view that auroras and halos are indexes of atmospheric electrification, there should be a maximum of the solar halos between 9 and 10 a.m., corresponding with the maximum of the auroras about 9 or 10 p.m., the two coming simultaneously with the two maxima of daily electrification of the atmosphere occurring about those times of the day (12 hours apart) which latter so many investigators have shown. The solar halos I have noted, during a period of thirty years, have the ratio of 4 forenoon, to 3 afternoon, halos; but as I recorded only rarer forms, and did not make a complete census, the proof of a maximum of halos in the forenoon would not necessarily lie in this data. The trend, however, toward a forenoon maximum, is evident from the casual record I have made of the rarer forms, and in accordance with the maxima of atmospheric electrification.

Apart from the work of the sounding balloons, the loftiest parts of the atmosphere can be studied only by means of halos, auroras, sunset glows, and other phenomena of the cirrus hazes sometimes seen in those higher altitudes. The optical phenomena which are common enough, especially in our Canadian winters, promise an abundant return of data if properly worked. But this can only be done when the ordinary optical phenomena of the atmosphere are fully understood and interpreted by as large a number of observers as possible. A person who can discriminate what is evidence from what is not, is capable of making an observation that may serve to help this line of science,—the optical phenomena of the air. Speculation is always of secondary value; it is only a good observation that has value of the highest kind.

SIMULTANEOUS VARIATIONS IN SOLAR RADIATION AND SPECTROSCOPIC DETERMINATIONS OF THE SOLAR ROTATION.

By Ralph E. De Lury.

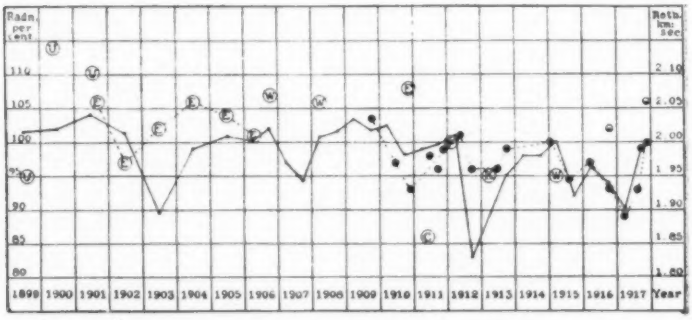
VARIATIONS in spectroscopic measurements of the rate of the sun's rotation have been ascribed by the writer to changes in haze between the sun and the earth or in their atmospheres[1]; and it has been suggested that simultaneous measurements of the intensity of solar radiation would exhibit corresponding fluctuations if changes in haze were in reality the cause of the variations. It is therefore desirable that measurements of rotation and radiation be made at the same time and place, along with observations of sky brightness and polarization which change with terrestrial haziness, in order that the nature of the variations may be more definitely interpreted. In the meantime the following examination reveals general similarity in the variations of the rates of radiation and rotation measured at different observatories.

Annual or semi-annual means of intensities of solar radiation at the surface of the earth, expressed as percentages of the general mean for each station, have been charted by H. H. Kimball[2] from 1883 to 1912, as follows: Montpellier, France, 1883-1900; Lausanne, Switzerland, 1896-1903; Warsaw, Russia, 1901-1905; Washington, D.C., and Mount Weather, Va., 1905-1912. From these charts the accompanying graph, 1899-1912, has been taken, using up to 1905 means of overlapping series of observations; and this graph has been continued from 1912-1917 from the Washington solar radiation intensities published by Kimball

[1] *Journal* R. A. S. C., X., 201, and 343, 1916; *Astrophysical Journal*, XLIV., 177 and 198, 1916; also Oct., 1918.

[2] *Bulletin*, Mount Weather Observatory, V., 301, 1913.

in the numbers of the *Monthly Weather Review*, by taking half-yearly means of the a.m. values at 60° zenith distance and expressing these in terms of Kimball's means of a.m. values at 60° zenith distance for 1905-1910. The graph shows marked depressions in 1902-3 and 1912-13, due to general terrestrial haziness produced by the volcanic eruptions in the West Indies in 1902 and at Katmai, Alaska, in June, 1912, and smaller depressions in 1907 and 1915-17, due possibly, to haziness accompanying the solar activities, and the corresponding terrestrial electro-magnetic effects.



Graph of solar radiation percentages; with spectroscopic measurements of the equatorial rate of the solar rotation, as follows: U, Upsala, Dunér; E, Edinburgh, Halm, 1901-6, and Storey and Wilson, 1910; W, Mount Wilson, Adams, 1906 and 1908, and St. John, Adams and Ware, 1914-5; C, Cambridge, England, Hubrecht; P, Pittsburgh, Schlesinger; K, Kodaikánal, Evershed and Royds; small circles, black (limb), and half black (midway centre to limb), Ottawa, DeLury.

Along with the graph of intensities of solar radiation are plotted measurements of the rate of rotation at the solar equator as determined by the displacements of the spectrum lines. Both sets of measurements are of course affected by local haziness and circumstances which may offset the general terrestrial conditions, yet nevertheless, it is apparent that general terrestrial haziness lessens the values of both: this is also seen in the following numerical statement:

Year	Radiation Percentages	Rotation km. per sec.	Observer	Observatory
1887-8-9	102	2.09	Dunér	Upsala
1899-0-1	102	2·05	"	"
1901·7	104	2·06	Halm	Edinburgh
1902·5	100±	1·97	"	"
1903·4	90±	2·02	"	"
1904·5	99±	2·06	"	"
1905·5	101	2·04	"	"
1906·3	101	2·01	"	"
1910·9	98	2·08	Storey and Wilson	"
1906·8	101	2·07	Adams	Mount Wilson
1908·3	101	2·06	"	" "
1914·15	97±	1·95	St. John, Adams, Ware	" "
1909·8	102	2·04	DeLury	Ottawa
1910·5	100	1·97	"	"
1910·9	98	1·93	"	"
1911·7	100−	1·98	" 2·01 J. S. Plaskett	"
1912·4	100+	2·01	" 2·01 "	"
1912·8	83±	1·96	" 2·00 "	"
1913·4	93±	1·96	" 1·99 " 1·98 H. Plaskett	"
1913·7	95	1·99	" (1·97) "	"
1915·1	100−	2·00	"	"
1915·5	95	1·94	" 1·95 "	"
1916·3	96	1·97	"	"
1916·8	93	1·93	"	"
1917·2	90	1·89	"	"
1917·6	96	1·93	"	"
1917·8	98	1·98	"	"
1911·4	99	1·86	Hubrecht	Cambridge, Eng.
1911-12	100-83	2·00	Schlesinger	Pittsburgh
1911-12	95±	1·95± ·1	Evershed and Royds	Kodaikánal
1913·2	90±	1·95±	" "	"

Means for Radiation Percentages 100 or over:

101 2·03

Means for Radiation Percentages less than 100:

95 1·97

Thus a drop of 6 per cent. from the average intensity of solar radiation is accompanied by a lessening of 3 per cent. in spectroscopic measurements of the rate of rotation at the sun's equator.

Dunér's high values of the rate of rotation of the sun were measured at times of high radiation. Halm's values show a drop in 1902 and 1903, ascribed by him to changes in the sun. It is probable that the haze produced by the volcanoes in the West Indies (May to October, 1902) affected his measurements, though

he mentions precautions taken to avoid the effects of sky spectrum[1]. It is significant, however, that the means of his August observations in 1901 and 1902 were respectively (for departures from the equator of 8° and under), 2.08 km. per sec., 4.°3, 29 observations, and 1.88 km. per sec., 4°.6, 6 observations; also, that (for departures from the equator of 10° or less) in 1902, for the interval, Feb. 12-April 29, 24 observations yielded a mean of 2.02 km. per sec., average angle 4°.9, while for the interval, June 30-Sept. 19, 20 observations yielded a mean velocity of 1.96 km. per sec., average angle 5°.0, respectively before and after the May and June eruptions in the West Indies. The Mount Wilson measures show agreement also with the radiation values, being higher in 1906 and 1908 than in 1914-15. For the period 1909 to 1917, the writer's measurements of rotation[2] fluctuate with the variations in H. H. Kimball's measures of radiation at Washington, D.C. It is reasonable to suppose that the writer's values in 1912.8 were lessened by the residual haziness from Katmai, it being impossible to make suitable observations during July, August and September of that year owing to this cause. It is probable also that the very low values obtained by Evershed and Royds during the latter part of 1912 and the still low values in the first five months of 1913 were caused by the haze produced by Katmai. Local conditions probably account for the exceptional values obtained by Storey and Wilson and by Hubrecht. The Upsala and Edinburgh values are high relatively to most of the other measures, possibly because they were measured in the red part of the spectrum, where the effect of haze appears to be not so great as in the more refrangible part of the spectrum.

[1] *Trans. Royal Soc. of Edinburgh*, XLI., Part. I, 89, 1904.

[2] On the accompanying chart at 1916.8 and 1917.9 are shown two half-blackened circles which indicate the values of rotation determined from spectra of points half way out from centre to limb along the equator, while the limb values for the same dates are denoted by the black circles; the latter values are smaller than the midway values, probably due to blended spectrum of haze, as explained in the note following the present one in this JOURNAL.

On the whole the synchronization of the variations in measurements of solar radiation and rotation is fairly good, considering that momentary local conditions may affect either observation profoundly. It is important that both observations be made precisely simultaneously at the same place. From such observations it may be possible to deduce relationships such that the variations in solar radiation (due to haze) could be computed from the rotational displacements of spectrum lines,—particularly those lines which are most lessened by the blending with the spectrum of haze. At the present time there is no sound reason for believing that the variations in the spectroscopic measurements of the rate of the sun's rotation indicate real solar phenomena.

DOMINION OBSERVATORY,
OTTAWA, CANADA,
OCTOBER, 1918.

SPECTROSCOPIC MEASUREMENTS OF THE SOLAR ROTATION AT THE EQUATORIAL LIMBS AND AT POINTS MIDWAY BETWEEN THEM AND THE CENTRE OF THE SOLAR DISC.

By Ralph E. De Lury.

BY employing a pair of double-tongued reflecting prisms[1] over the slit of the solar spectrograph, and by means of two other reflecting prisms (W and E in the diagram) directing to these prisms beams of light from within the limbs of the solar disc at points diametrically opposite, it is possible to photograph simultaneously two pairs of strips of limb spectra with a strip of spectrum from the centre of the solar disc,—and also, if desired, two strips of spectra from points symmetrically above and below the centre of the disc. Such a system of prisms has been employed at Ottawa since 1913. In many of the observations a tube containing iodine vapour is placed over the tongued prisms in such a way that the beams of light from the points above and below the centre of the solar disc pass through the iodine vapour (which is maintained at a constant pressure of 250 mm., and temperature of 50°-80° C., thus producing a standard iodine absorption spectrum), while the beam of light from the centre of the disc is protected from the iodine vapour by a thin-walled brass tube of 3 mm. bore, which is held in the centre of the iodine tube and is pressed tightly against its plate glass ends. During the past two years this apparatus has been improved further by mounting prisms MW and ME (see diagram) so that they cut out one strip of spectrum from each limb and supply instead strips of spectra from points about midway between the limbs and the centre of the disc. A convenient arrangement has also been installed for obtaining arc (or spark) spectra through the MW and ME prisms.

[1] De Lury, Report of the Chief Astronomer, Ottawa, 1911, p. 290.

Also, prisms at the S and N limbs direct beams of light to two more prisms mounted over the slit above and below the double-tongued prisms, making possible the photography of two extra strips of limb spectra. A mm. comb placed over the slit insures a spacing of 1 mm. from the middle of one strip of spectrum to the middle of the next strip. It is thus possible to photograph simul-

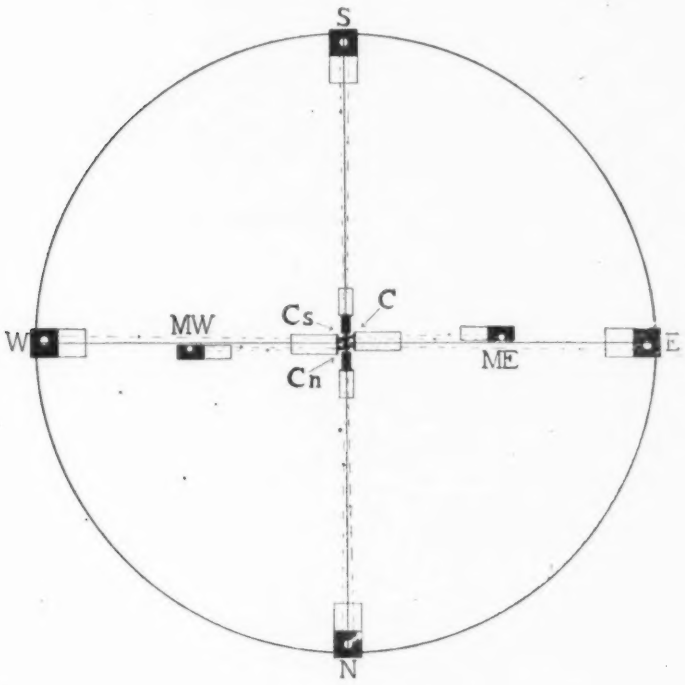


Diagram representing the solar disc (circle 228 mm. in diameter), and the arrangement of reflecting prisms whose diagonal surfaces (in heavy black) direct beams of light from various points on the solar disc (white circles on black at N, E, S, W, MW and ME) to the tongued prisms which redirect the light through the spectrograph-slit which lies under the NS diameter at the centre.

taneously nine strips of spectra adjacent to one another in the following order, namely, a strip from each of the following sources: S (south limb), Cs (3 mm. south of the centre of the solar disc, with or without iodine absorption), ME (midway between centre and east limb; or electric arc), W (west limb), C (centre of solar disc), E (east limb), MW (midway between centre and west limb; or electric arc), Cn (3 mm. north of the centre of the solar disc, with or without iodine absorption), N (north limb). By rotating the spectrograph, any four quadrantal points may be observed at the limb instead of the N, E, S, W points.

This arrangement of reflecting prisms makes possible the simultaneous investigation of many problems relating to the determinations of the character and wave-lengths of solar and arc spectrum lines from various sources. One of these is the determinations of the equatorial rate of the solar rotation from the spectrum line-displacements at the limbs and at points midway between them and the centre of the disc, from photographs of the spectra made at the same time. These determinations will furnish an independent test of the presence of a blended spectrum of haze, evidence of which the writer has found in other ways[1]; for the limb spectrum is weaker and its lines more weakened relatively to the centre spectrum or the haze spectrum than is the case with the spectrum from the midway point, and consequently the blended spectrum of haze will lessen the values of the rate of rotation as determined from the limb line-displacements probably more than it lessens the values derived from the line-displacements in the spectra of the midway points. Many such photographic observations of the limb and midway spectra have been made, and those measured up to the present indicate a decided tendency to yield larger values for the rate of rotation from the midway spectra than for the limb spectra. Only an outline of these results will be given here.

To determine the line-displacements from the spectra indi-

[1] This JOURNAL, Vol. X, pp. 201 and 343, 1916; and November, 1918 (preceding this). Also, *Astrophysical Journal*, XLIV, 177 and 198, 1915; and Oct., 1918.

cated in the diagram, MW-ME and W-E, it is necessary to determine very accurately the tilt of the spider thread of the micrometer to the spectrum lines. This may be done by measuring the displacement of the solar or iodine spectrim lines in Cs relatively to those in Cu, or possibly in N relatively to S. An error in determining this tilt will be twice as great for the displacement in MW-ME as for the displacement in W-E, and of opposite sign. This will cause an error in the derived rates of rotation which will be four times greater in the midway values than in the limb values. The limb measurements are found to be much more stable than the midway measurements, particularly when only a few lines are measured for determining the tilt of the micrometer line to the spectrum lines. The measurements of 75 plates taken during various degrees of haziness yielded the following values of the rate of the solar equatorial rotation from the limbs and the midway points:

Number of plates.	λ	Limb Rotation km. per sec.	Midway Rotation, km. per sec.	Difference, km. per sec.
56	5600	1.885	1.994	0.109
14	5200	1.913	2.006	0.093
5	3950	1.996	2.061	0.066

On the plates at λ 5200, lines of intensities 1 to 30 were measured with the following results relating to velocity and line-intensity:

Mean Intensity	2.9	22	Difference,
Number of lines	9	3	km. per sec.
Velocity, km. per sec., Limb.	1.900	1.954	0.054
Velocity, km. per sec., Midway	1.997	2.023	0.026

If, as has been suggested (*loc. cit.*), the magnitude of the difference in velocity determined from groups of weak and of strong lines be taken as a measure of the magnitude of the effect of blended spectrum of haze, it would seem (as expected) that the effect is greater on limb spectra (difference, 0.054) than on midway spectra (difference, 0.026), and as a result the rate of rotation derived from the midway spectra (2.006) is greater than that derived from the limb spectra (1.913).

It is desirable that many more measurements be made, and that the law of change in passing out to the limb of the sun be investigated; and it may be that the value of the solar rotation, unaffected by blended spectra, may be inferred therefrom. It may be noted also, that such investigations will enable one to make distinctions between Adams' level hypothesis and that of blended spectra in explaining the differences in velocity,—such distinctions as have already been made (*loc. cit*) from other considerations; and furthermore, such investigations will enable one to determine at the same time the changes in the wave-lengths of the spectrum lines in passing from the centre of the solar disc to the limbs.

DOMINION OBSERVATORY,
OTTAWA, CANADA,
OCTOBER, 1918.

THE ORBIT OF THE SPECTROSCOPIC BINARY *h* DRACONIS

By W. E. Harper

THIS star ($\alpha = 16^h\,56^m$, $\delta = +65°\,16'$, photographic magnitude 5·3, type *F*5) was announced a spectroscopic binary by Campbell in *Astrophysical Journal*, Vol. X., p. 178. His four observations, given in the table of measures, show a range of 20 km. The star was placed on our observing program eleven

MEASUREMENTS OF *h* DRACONIS

Plate	Date	Julian Date	Phase	Velocity	Wt.	O-C
Lick	1899, June 26	2,414,832·8*	19·05	- 26		+1·1
Lick	July 11	2,414,847·8	34·05	36		+2·0
Lick	" 16	2,414,852·8	39·05	32		+0·7
Lick	" 24	2,414,860·8	47·05	16		-0·9
8451	1918, Feb. 17	2,421,642·907	3·44	1·5	19	+1·1
8471	Mar. 10	663·775	24·31	34·6	11	0·0
8482	" 27	680·710	41·24	33·2	11	-4·2
8498	Apr. 9	693·704	2·52	2·0	17	+0·8
8501	" 14	698·720	7·54	4·2	11	+1·6
8506	" 19	703·651	12·47	13·9	16	+0·5
8510	" 22	706·647	15·47	20·7	10	-0·1
8512	" 24	708·688	17·51	25·4	15	-0·9
8517	" 26	710 667	19·49	26·4	13	+1·5
8520	May 8	722·602	31·42	40·1	14	-1·5
8521	" 8	722·656	31·48	40·3	11	-1·7
8522	" 14	728·690	37·51	35·8	12	-0·8
8525	" 20	734·657	43·48	20·4	12	+3·7
8537	June 5	750·647	7·76	6·6	2	-0·6
8539	" 7	752·693	9·80	10·3	12	-0·8
8580	" 18	763·656	20·77	28·6	7	+1·3
8593	" 25	770·610	27·72	35·0	3	+2·5
8611	July 9	784·604	41·71	27·6	12	+0·3
8617	" 12	787·684	44·79	22·8	22	-2·0
8622	" 17	792·699	49·81	9·7	17	-1·1
8639	Aug. 25	831·685	37·08	32·9	5	+2·5
8640	" 26	832·573	37·97	29·8	15	+4·5
8645	" 29	835·651	41·05	30·5	22	-1·1
8649	Sept. 13	850·550	4·24	5·3	10	-2·6
8650	" 17	2,421,854·664	8·35	- 7·1	11	-0·1

* The decimal of a day is assumed.

years ago but it was not followed up until this year when 25 spectrograms were obtained with the single prism spectrograph. This is somewhat fewer than the number of observations generally used in determining an orbit but as the lines are very good for measurement and some 15 or 20 were used on each plate, the resulting velocities show no large residuals from the final curve, the probable error of a plate being ± 1·3 km. per second.

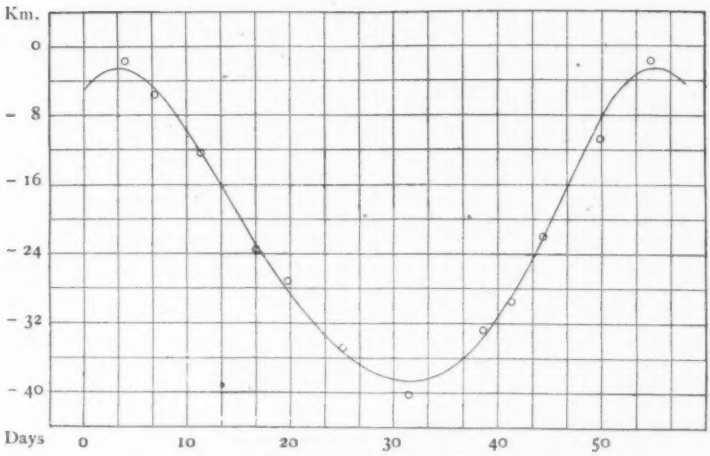
Our own observations when plotted suggest a period about 50 days. If the correct number of cycles has been taken to connect up the Lick observations with our own, the period determined, 51·710 days should be correct at least to the second decimal place. With this period the Ottawa observations were grouped according to phase into 11 normal places and graphical elements determined as follows :

$$P = 51{\cdot}710 \text{ days}$$
$$e = {\cdot}15$$
$$\omega = 330°$$
$$K = 18{\cdot}25 \text{ km.}$$
$$\gamma = -22{\cdot}62 \text{ km.}$$
$$T = \text{J.D. } 2{,}414{,}813{\cdot}93$$

NORMAL PLACES

	Final Mean Phase	Mean Velocity	Wt.	Final O-C		Final Mean Phase	Mean Velocity	Wt.	Final O-C
1	19·94	-27·17	2·0	+ 1·32	7	49·81	9·70	1·5	- 1·13
2	25·04	34·70	1·5	+ ·59	8	3·01	1·74	3·5	+ ·98
3	31·45	40·19	2·5	- 1·62	9	6·84	5·60	3·5	- ·66
4	38·57	32·68	4·0	+ ·98	10	11·33	12·36	2·5	+ ·05
5	41·29	29·48	3·5	- ·50	11	16·69	-23·52	2·5	- ·51
6	44·32	21·95	3·5	+ ·12					

Using the differential formula of Lehmann-Filhés observation equations were built up connecting the residuals with the elements whose values were to be improved upon, namely, γ, K, e, ω and T. From the solution there resulted small corrections with a corresponding reduction of Σpvv for the normal places from 29·6 to 22·2. The final elements are :



RADIAL VELOCITY CURVE OF *h* DRACONIS

P =	51·710 days	
e =	·128	± ·035
ω =	329°·32	± 14°·09
K =	17·96 km.	± ·70 km.
γ =	− 22·59 km.	± ·47 km.
T =	J.D. 2,414,813·75.	± 1·996 days.
$a \sin i$ =	12,625,000 km.	
$\frac{m_1^3 \sin^3 i}{(m+m_1)^2}$ =	·03 × sun.	

DOMINION OBSERVATORY,
OTTAWA, CANADA.
October, 1918.

THE MOON AND THE GLACIAL PERIOD.

By A. V. Franklin.

IN presenting the following conjectures, as an amateur, on a problem fraught with pitfalls, it is made with the greatest hesitancy, and nothing is attempted other than to set out the general lines of an idea which occurred to me, trusting there may be a germ of reason somewhere that otherwise might be lost.

Looking back to the time when our earth was very many years younger; back, in fact, to around the latter half of the Tertiary Period, we come upon the phenomenon of a climate in our northern latitudes dropping from tropical to glacial; ice piling up in the extreme north and finally over-running more southern countries. Following this state, the climate beginning to mend: the glaciers to retreat or melt, and continuity of climate more or less uniformly re-established (though at a much lower level) until the present age.

This, roughly, sums up our proposition and is deduced from the earth itself. To account for it satisfactorily, however, is another and far more complex matter, resulting from the meagre working data, or, perhaps, to be still more strictly correct, our imperfect knowledge of natural laws; for the former depends entirely upon the latter.

A glance over the field of deduction and surmise shows that the general lines followed have been: (1) of the earth itself; (2) its obliquity to its orbit; (3) its peculiarities of orbit; (4) of the sun. And yet the problem still remains unsolved in a larger degree.

But there is another factor, it seems to me, that could have played one of the most important parts of all, i.e., the moon. What if the moon had been active for some considerable time

prior to the Glacial Period, generating heat and light and endowing our earth with a generous portion in a steady stream?

Why not? We believe that as far back as the Glacial Period at least there is nothing to show of any lunar effects on the earth materially different from what is produced to-day. But pre-glacially! Here we see the effects of something very strong and virile, giving tropical climate to our northern latitudes. We do not believe it came from local changes, a change in the earth's axis, or from the sun. Then what of our close and huge satellite?

The moon may have followed a very different process of evolution from our earth and, accepting the theory that it was initially a throw-off from the earth in a mass of meteoric matter, there is nothing to show when this matter fused and finally became a planet; or when it cooled. We only know that its internal heat at the last was such that it burst the shell and dissipated in a series of gigantic outpours by the very fact of its appearance to-day.

Yet so many objections are there to overcome regarding such a sub-sun that it would be vain in a brief sketch to attempt to analyse them, and I can only re-assert for my present purpose that when we project our arguments to periods like these—notwithstanding our knowledge—most claims become more or less subject to abandonment; for, to all we know to the contrary, the birth of the moon from an assumed conglomerate mass may have taken place any time in either our Paleozoic, Pre-Cambrian or earlier eras.

But we know this must have happened—and pre-glacially. When? With my very limited powers I would not hazard a guess; yet I venture to put the hypothesis that, given our moon, capable of producing the excess heat and light which must be necessary to have thrown a tropical atmosphere around our present cold zone for at least many thousands of years in a fairly even manner, then the facts we are faced with to-day would be nearer solution.

As to the extensive period required for the moon to have produced such a climate, it may be suggested in passing that the recent experiments in radio-activity are leading us into an entire-

ly new field as to the composition of matter and its activities and, as the late Dr. W. E. Wilson showed as regards the sun, were an excessively minute percentage of radium found there, that fact alone would account for the now irreconcilable difference in its age as set forward by geologists against astronomical deduction.

The moon's bulk, too, must have been very much greater; its relative distance less and its orbit largely at variance with the present. These are matters of prime importance when brought to bear upon the earth and, in the main, their deduction would be abstruse; while, further, it must be remembered that the heat and light received by the earth is subject to the class of sun the moon happened to come under.

Passing on to the final stage of our problem—the period when the climate of the earth had to subsist, as at present, on the sun's rays—we come upon the dawn of the Glacial Period.

I do not advocate that the moon's failure alone brought on the Glacial Period, but add to this circumstance an assumption that the following facts (1) and (2) were in conjunction: (1) the revolution of the earth's axis had carried our northern hemisphere into much the same relative position to its orbital plane as the southern hemisphere occupies to-day; (2) one of the long periods when our earth's orbit flattened out and the earth was approaching its greatest distance from the sun. Then would not the inevitable result be the Glacial Period? The climate subsequently re-adjusted itself to the better conditions following?

Facts (1) and (2) have already been fully expounded by Croll in this connection: I merely present the additional (assumed) circumstance. Moreover, knowing climatic conditions pre-glacially in the zone affected have had no parallel since; this fact and the consequent reactions attendant upon it seems to lead us to the conclusion that any re-occurrence of (1) and (2) will not again produce a cold era of such vastness as the glacial.

THE PAS,
MANITOBA, CAN.

THE MONTREAL CENTRE OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA.

By W. E. W. Jackson, *General Secretary.*

EVER since becoming a member of the R.A.S.C., it appeared strange to me that an educational centre of the importance of Montreal should be without a branch organization of our Society. On various occasions I spoke of this matter to different members, and without exception they all considered that a centre should be established there; but owing to the small membership in that locality, they were for the most part of the opinion that the time was not yet opportune. Mr. Asbury, of Montreal, had suggested some years ago that there be a centre there, but the matter had been dropped, I presume, from lack of support.

Last January I received a letter from one of our members, Rev. W. T. B. Crombie, of Kingsbury, Que., in which he referred to the pleasure he received from perusal of the Journal, and the loss he felt he sustained in being unable to attend the regular meetings of the Society in Toronto. To remedy this loss, he suggested, that a centre of the Society be established at some suitable place in the Province of Quebec, and he asked for the approval of the Society and their assistance.

This communication I was pleased to place before the General Council at its meeting on February 22, 1918, and after some discussion it was considered advisable to have a centre established in the Province of Quebec, preferably in the city of Montreal. The Secretary was instructed by Council to write to Rev. Mr. Crombie to this effect, and give him every encouragement and assure him of the support of the Council.

Rev. Mr. Crombie, on receipt of this letter, addressed a personal letter to each member of the Society resident in the Province

of Quebec and asked them to furnish replies to the three following queries:—

1. Would the formation of a centre of the R.A.S.C. in Montreal assist you in the further prosecution of your astronomical studies or increase your interest in the same?

2. Can you foresee any substantial difficulty in the way of the formation of such centre?

3. Can you offer or suggest a place where we could meet to organize and make further arrangements?

Rev. Mr. Crombie says that to this letter replies were received from eleven out of the fourteen members. The non-response of two out of the remaining three was afterwards quite satisfactorily explained. The replies themselves were of an exceedingly encouraging character, not a few of them being quite enthusiastic. No obstacle was hinted at and a number of places were offered for the first meeting. The offer of Mr. Jas. Weir, B.Sc., of the Dept. of Geodesy, of a class room in the Engineering Building of McGill University was accepted. Accordingly notices were sent to all members, of a meeting to be held on May 28 to organize.

A short time after receiving Rev. Mr. Crombie's letter one was received from Mr. Asbury again suggesting the formation of a centre in Montreal, and I told him of the action already taken by the Council in reference to Rev. Mr. Crombie's proposal.

The meeting called for May 28 was duly held, and the following extract of the minutes of the meeting tell how successful was the work of Rev. Mr. Crombie:—

"At Montreal, and within the Engineering Building of McGill University, the members of the Royal Astronomical Society of Canada resident in the Province of Quebec met (pursuant to notice sent to each member) on the twenty-eighth day of May, one thousand nine hundred and eighteen, the following members being present: Jas. Weir, B.Sc., Montreal; H. E. S. Asbury, Westmount; Mgr. C. P. Choquette, Lic.Scs., St. Hyacinthe; Lt.-Col. W. E. Lyman, B.A., Montreal; Geo. Sample, Montreal;

John Corway, Montreal; Rev. W. T. B. Crombie, M.A., B.D., Kingsbury.

"The object of the meeting was to organize a centre of the R.A.S.C. for the Province of Quebec, elect officers and make further arrangements.

"Mr. James Weir, B.Sc., was appointed to the chair for the evening and Rev. W. T. B. Crombie acted as secretary pro tem.

"Rev. Mr. Crombie narrated the steps that led up to the calling of the present meeting, and after each member present had expressed his mind and letters of absent members had been read, the meeting proceeded to the election of officers, which resulted as follows:—

"*President*—Mgr. Choquette, M.A., Lic.Scs., St. Hyacinthe.

"*Vice-President*—H. E. S. Asbury, Westmount.

"*Secretary-Treasurer*—Rev. W. T. B. Crombie, M.A., B.D., Kingsbury.

"*Council*—George Sample, James Weir, B.Sc., Lt.-Col. R. Wilson, Lt.-Col. W. E. Lyman, B.A., John Corway.

"It was decided to hold the meetings in the Engineering Building, which, we were assured, would be available at a small expense in the evenings; that the Society hold its inauguration meeting in the month of September next, and that Dr. Otto Klotz, Chief Astronomer and Director of the Dominion Observatory, Ottawa, be invited to address the meeting, the date of the meeting to be arranged."

Rev. Mr. Crombie reported to the General Secretary, under date of May 31, 1918, the results that had so far been obtained and his report was presented to General Council at its meeting on June 21, 1918. The action taken by the Quebec members in forming a centre in Montreal was unanimously approved.

It is very gratifying to know that the membership of the Montreal centre has already more than doubled.

October 15.—The regular meeting was held in the Society's rooms, 198 College Street, at 8 p.m., the President, Mr. A. F. Miller, in the chair.

Mr. F. Kerr, Alexandria, Ont., was elected a member of the Society.

Prof. Chant mentioned that Dr. R. H. Mode, of Toronto, when observing the rainbows on the previous Sunday evening, had counted as many as five, all visible at the same time.

Mr. A. F. Miller had seen a rainbow in the direction of the sun on the same afternoon, which was quite an unusual direction. Mr. Miller also referred to the peculiar red colored light of the sky the same Sunday forenoon (Oct. 13), and attributed it to the extensive fires in Minnesota the previous week, and he recalled the dark day of Sept. 5, 1881, caused by the Michigan fires and bush fires in Ontario. Mr. A. F. Hunter had witnessed the red colored sky at Barrie on the forenoon of the 13th, thus showing that the phenomenon was widespread, and he had also assigned its origin to the Minnesota fires.

Mr. Miller has continued to observe Nova Aquilae regularly, and reported that it is not now diminishing in brightness very fast. In the telescope it now gives a dull light, not a bright light as it gave when about its maximum.

Mr. F. L. Blake mentioned an important earthquake on Oct. 11th, the seismograph record of the earthquake made at the Observatory showing, according to calculations by Mr. Young, that the disturbance took place south of the Island of Hayti, and was submarine. The disturbance began at 9.16 (E.S.T.) on the morning of the 11th, had its maximum at 9.35, and tremors continued until 2 o'clock in the afternoon. The seismograph record was a beautiful one. (See page 470 of this number.)

Prof. C. A. Chant gave the paper for the evening on "Observations of the Total Solar Eclipse of June 8, 1918." He introduced the subject with a brief general discussion of eclipses of the sun, and then described his experiences at Matheson, Colorado.

An account of this expedition has already appeared in the JOURNAL.

The paper was illustrated with lantern slides. An interesting illustration was one showing sunlight on the wall of a house, the sun images being crescent figures instead of round disks, as they are when the sun is not in eclipse.

In the general discussion following the paper, some reference was made to the shadow bands. These do not travel so fast as the moon's shadow. Prof. Chant answered numerous questions from members present, after which the meeting adjourned.

A. F. HUNTER,
Recorder.

NOTES FROM

THE DOMINION ASTROPHYSICAL OBSERVATORY

VICTORIA, B.C.

The table following contains a list of the first twelve spectroscopic binaries discovered in the course of the regular radial velocity program of this Observatory. The mirror arrived at the Observatory on April 29, the first spectrum was obtained on May 6, and in the measurement of some of the 750 spectra secured since that date, these binaries have been discovered.

It has seemed best, in view of succeeding lists, to give serial numbers to these binaries and to arrange them in tabular form in order of right ascension for convenience of reference. Notes in regard to the character of the spectrum, etc., which in general are too long to be incorporated in the table, are given below the latter, the aim being to make the data about each of these stars as complete as possible.

In the table, Column 1 contains the serial number of the binary. Column 2 gives the number of the star in Boss's Catalogue and in the Revised Harvard Photometry and its Right Ascension and Declination for 1900. Column 3 gives the visual magnitude and spectral type according to the Revised Harvard Photometry. Columns 4 and 5 give the date and Greenwich Mean Time of the observations. Column 6 contains the measured radial velocity given to tenths of kilometres. Column 7 gives the respective quality of the individual plates as regards suitable exposure and development but does not give any indication of the character of the lines. The last column gives the discoverer, P standing for Plaskett, Y for Young.

No.	Star R.A. (1900) Dec. (1900)	Type Mag.	Date	G.M.T.	Radial Velocity	Quality	Discoverer
			1918	h m			
1	Boss 4098		May 21	20 22	− 29·1	Good	Y
	H.R. 6004	A	" 24	19 24	− 22·6	"	
	16h 02m·9	5·63	June 14	18 35	− 42·7	"	
	+10° 10′		July 16	17 32	− 13·4	Fair	
2	Boss 4104		May 24	20 22	− 28·5	Good	Y
	H.R. 6013	A	June 17	18 56	− 80·7	"	
	16h 04m·2	6·07	July 11	17 06	− 16·3	"	
	+17° 30′						
3	Boss 4123		May 22	19 45	+ 11·5	Fair	P
	H.R. 6036	A	June 19	18 08	− 1·6	Good	
	16h 07m·1	6·31	" 26	17 32	− 26·9	"	
	+58° 12′		July 24	16 36	− 8·0	"	
4	Boss 4602		June 19	20 20	+ 12·0	Good	P
	H.R. 6809	F5	" 22	19 18	+ 18·6	"	
	18h 07m·5	6·18	" 26	18 29	− 1·2	"	
	+79° 59′		July 21	17 16	+ 23·3	"	
5	Boss 4661		May 27	22 40	− 41·1	Good	Y
	H.R. 6903	A2	June 14	21 09	− 23·3	"	
	18h 20m·9	5·04	July 5	19 03	− 45·1	"	
	+39° 27′		" 11	20 08	− 22·6	"	
			Aug. 27	15 58	− 19·7	"	
			Sept. 20	15 34	− 43·4	Fair	
6	Boss 4669		June 24	20 19	+ 39·4	Good	Y
	H.R. 6917	A	July 11	19 56	− 10·9	"	
	18h 22m·1	5·71	Aug. 27	15 41	− 9·8	"	
	+29° 46′		Sept. 20	16 07	+ 28·6	Fair	
7	Boss 4706		June 26	21 22	− 40·4	Good	P
	H.R. 6977	A	" 29	19 00	− 36·5	"	
	18h 30m·8	5·73	July 21	18 23	− 30·5	Fair	
	+18° 07′		" 24	18 10	− 22·8	Good	
			Oct. 13	14 34	− 7·1	"	
			" 15	15 13	+ 16·8	Fair	
8	Boss 4870		May 24	22 48	− 36·7	Good	Y
	H.R. 7258	A	June 14	22 33	− 15·0	"	
	19h 03m·1	6·15	" 17	20 09	− 29·8	"	
	+41° 16′		" 18	21 57	− 32·6	"	
			" 27	21 29	− 30·7	Fair	
			" 28	21 08	− 19·6	Good	
			Aug. 5	18 48	− 8·0	"	
9	Boss 5236		June 28	22 09	− 35·1	Fair	P
	H.R. 7807	A	Aug. 3	20 29	− 43·8	Good	
	20h 20m·0	5·68	Oct. 15	16 02	− 56·2	Fair	
	+37° 10′		" 19	15 34	− 46·7	Good	

No.	Star R.A. (1900) Dec. (1900)	Type Mag.	Date	G.M.T. h	G.M.T. m	Radial Velocity	Quality	Discoverer
10	.....		Aug. 23	18	36	− 50·3	Fair	P
	H.R. 8136	B5	" 24	20	20	− 54·1	"	
	21h 12m·2	6·32	" 25	20	49	− 60·7	"	
	+47° 33′		Sept. 7	19	07	+ 2·0	Good	
			" 14	18	52	− 5·9	"	
			" 15	18	11	− 6·8	Poor	
11	Boss 5918		Oct. 8	18	03	− 32·2	Good	P
	H.R. 8731	B3	" 13	17	21	+ 7·1	"	
	22h 52m·7	5·20	" 15	16	30	− 5·4	"	
	+48° 09′		" 19	16	35	− 5·7	"	
12	.....		Aug. 22	22	06	− 14·8	Fair	P
	H.R. 8803		" 23	20	31	+ 15·6	Good	
	23h 03m·0	B2	" 24	21	08	+ 71·8	"	
	+59° 13′	6·28	Sept. 4	19	22	+ 21·2	Fair	
			" 14	19	29	+ 81·8	Good	

No. 1. Calcium K, hydrogen lines H_δ, H_γ, H_β, and the magnesium line λ4481 were measured in the spectrum of this star. There are indications of numerous rather broad metallic lines showing on the plates. Magnesium λ4481 is very faint in comparison with the calcium K. The hydrogen lines are fairly well defined.

No. 2. The hydrogen series alone is measurable on spectrum plates of this star; magnesium line λ4481 and calcium K are both present but very faint.

No. 3. This spectrum, given as A in H.R., is approximately $A2$ as judged by the relative intensity of K and the H lines. The spectrum is composite and in consequence the lines generally are very broad and diffuse. In the last plate, where the components are separated by about 140 km., there are a number metallic lines present but otherwise only the hydrogen, λ4481 mg. and K are measurable.

No. 4. This spectrum, classified as $F5$, is more nearly solar type and is of good quality for measurement. The plates were measured on the Hartmann Spectro-Comparator. As measures of constant velocity solar type stars, with this engine, show that the probable error of a plate is well under 1 km. per sec. these velocities are probably equally accurate.

No. 5. The spectrum of this star is very much like that of star No. 1 save that there is practically no indications of faint metallic lines.

No. 6. Numerous fine metallic lines are present in the spectrum, thirteen to fifteen of which were measured. The type might be listed as *A*5 rather than type *A*. The hydrogen series and calcium *K* lines are also sharply defined.

No. 7. The hydrogen lines H_δ, H_γ, H_β although broad and intense in this star, are fairly well measurable. Mg. λ4481 is the best measurable line, and in some plates one or two other metallic lines which are all faint were measured. The spectral type is approximately *A*2.

No. 8 This star is given as *A* type in H.R. but it is really *B*2 type with sharp helium and silicon lines showing. The calcium *K* line is sharp and narrow and the measures on six of the plates indicate that it may exhibit a somewhat smaller range than the other lines present in the spectrum.

No. 9. This star classified as *A*, is undoubtedly an early *B* type and is peculiar in having very broad helium and hydrogen lines of low contrast and a narrow sharp calcium *K* which gives a smaller range than the broad lines. Both spectra show on two of the plates and on the last *K* is doubled as well as some of the diffuse lines.

No. 10. The lines are broad and diffuse with the exception of calcium *K*. Mg. λ4481 is faint and not measurable on all the plates. The spectrum is probably composite as the helium lines on one plate indicate doubling.

No. 11. This spectrum is similar to that of No. 9 and in addition calcium *H* is sometimes separated from H_ϵ, and *H* and *K* give a smaller range than the helium and hydrogen lines. Spectrum possibly double.

No. 12. This spectrum is very suitable for accurate measurement, containing good helium, silicon, calcium, magnesium and hydrogen lines, but it is also peculiar in the smaller range given by calcium. On two of the plates one or two of the lines give indications of doubling.

VICTORIA, J. S. PLASKETT
October 23, 1918 *Director.*

NOTES FROM THE METEOROLOGICAL SERVICE

Summary Report of the Weather in Canada

September, 1918

Temperature.—The temperature was 4° above the average throughout British Columbia, 2° to 6° above in Alberta, about average in the Western portion of Saskatchewan, a little above in Prince Edward Island and Cape Breton, and everywhere else in the Dominion below the average, the discrepancies being very marked from Eastern Manitoba eastward to Western Quebec, and varying from 4° to 10°. In Eastern Quebec, New Brunswick and Nova Scotia, the negative departure ranged from 1° to 2°.

Precipitation.—Throughout British Columbia and eastward to Lake Superior very little rain fell, Prince Rupert recording seven inches less than usual, Vancouver four inches less, and the Western Provinces about a third of the customary quantity. From Lake Superior eastward to our Atlantic Coast the conditions were exactly opposite, the rainfall being everywhere exceptionally heavy, some localities experiencing an almost record amount for September; no station had less than four inches of rain, while some of the marked falls were:—Quebec 9·40 inches, Yarmouth 8·80 inches, Montreal 7·90 inches, Ottawa 6·30 inches, Charlottetown, Anticosti and Father Point 5·90 inches, Cochrane 5·40 inches.

Temperature for September, 1918

Station	September		Station	September	
	Highest	Lowest		Highest	Lowest
Yukon			Kenora	74	26
Dawson	74	24	Kinmount	79	23
British Columbia			Kingston	76	34
Atlin	73	26	Kitchener	78	34
Agassiz	90	39	London	80	34
Barkerville	69	30	Lucknow	76	30
Kamloops	84	42	Markdale	77	28
New Westminster	84	44	North Gower	80	25
Prince Rupert	79	42	Oshawa	76	33
Vancouver	78	46	Ottawa	80	30
Victoria	82	48	Paris	80	35
Western Provinces			Parry Sound	74	28
Battleford	84	20	Peterboro'	82	31
Calgary	84	30	Port Arthur	71	25
Edmonton	82	27	Port Burwell	75	37
Medicine Hat	87	28	Port Dover	78	36
Minnedosa	82	24	Port Stanley	77	34
Moose Jaw	87	20	Queensborough		
Oakbank	75	25	Ronville	73	31
Portage la Prairie	77	29	Southampton	76	35
Prince Albert	86	24	Sundridge		
Qu'Appelle	84	22	Stonecliffe	76	30
Regina	85	17	Stony Creek	80	36
Saskatoon	84	17	Toronto	81	39
Souris	78	22	Uxbridge	75	30
Swift Current	86	22	Wallaceburg	80	30
Winnipeg	76	28	Welland	80	33
Ontario			White River	68	20
Agincourt	81	36	*Quebec*		
Aurora	73	33	Brome	77	24
Bancroft	76	24	Father Point	76	30
Barrie	79	34	Montreal	78	34
Beatrice	77	28	Quebec	78	30
Bloomfield	76	33	Sherbrooke	80	29
Brantford					
Chapleau			*Maritime Provinces*		
Chatham	84	36	Charlottetown	70	40
Clinton	78	33	Chatham	78	32
Collingwood			Dalhousie		
Cottam	85	35	Fredericton	77	31
Georgetown	78	36	Halifax	78	36
Goderich			Moncton	80	31
Gravenhurst	79	30	St. John	84	30
Grimsby			Sussex	76	32
Guelph			Sydney	76	40
Haliburton	78	25	Yarmouth	80	34
Huntsville	76	29			

MAGNETIC OBSERVATIONS

August, 1918

During the month of August the Magnetic Forces at Agincourt were very restless. Large disturbances occurred on the 15th and 16th and from the 24th to the 27th. The first was the most pronounced and began suddenly on August 15th at $10^h\ 50^m$ with an increase in W. Dec. of 7′, in H of 72γ and in Z of 12γ, with immediate decreases of 20′, 115γ and 30γ respectively, following which the disturbance was in full force. Up to 21^h of the 15th the H and Z were generally much above normal and from then until about 10^h of the 16th below normal, with however some large and rapid fluctuations. The D was most disturbed about 13^h and 22^h of the 15th and 5^h to 6^h of the 16th.

The other large disturbance began gradually in the early hours of the 24th and continued to the 27th, the departures from normal were largest during the night hours of each day, whilst the disturbance was devoid of any sharp variations.

During August the sun's surface was very much spotted.

The Aurora was recorded, mostly in New Ontario, from the 8th to 15th and from 24th to 30th.

AGINCOURT MAGNETIC OBSERVATIONS

Lat. 43° 47′ N.; Long. 79° 16′ W.

August, 1918		D. West	H	Z	I
		° ′	γ	γ	° ′
	Mean of Month	6 38·0	15911	58347	74 44·8
	Maximum	7 14·5	16146	58546	
	Date of Maximum	16	15	31	
	Minimum	5 54·7	15706	58076	
	Date of Minimum	24	16	16	
	Monthly Range	1 19·8	440	470	
Mean Daily Amplitude	From hourly readings	17·5	61	36	
	From means of extremes	29·2	108	86	

MEANOOK MAGNETIC OBSERNATIONS

Lat. 54° 37′ N.; Long. 113° 21′ W.

August, 1918		D. East	H	Z	I
		° ′	γ	γ	° ′
	Mean of Month	27 43·2	12930	60270	77 53·5
	Maximum	29 44·9			
	Date of Maximum	15			
	Minimum	26 18·9			
	Date of Minimum	15			
	Monthly Range	3 26·0			
Mean Daily Amplitude	From hourly readings	18·4			
	From means of extremes	56·4			

H and Z are given in Gammas. (1 γ = 0·00001 C.G.S.).

All results are reduced to I.M.S.

The value of I at Meanook is the mean of all the observations made during the month without regard to the time of day.

The value of H at Meanook is the mean of two observations made about the middle of the month, and the Z is obtained by the formula Z = H tan I.

W. E. W. J.

Earthquake Records by the Milne Seismograph

TORONTO

Sir Frederic Stupart, Director.

P.T. = Preliminary Tremors. S. = Secondary Waves. L.W. = Large Waves. A.C. = Air Currents. Time is Greenwich Civil Mean Time, 0 or 24 h = midnight.

No.	Date 1918	P. T. Comm.	S. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Remarks
		h m	h m	h m	h m	h m	mm	
1893	Sept. 2			15 19·7 15 26·1		15 51·0	0·1	Early phases missed, light turned down.
1894	" 7	17 28·4? 17 29·3	17 37·0 17 38·8	17 40·8? 17 49·8	Between 18 13·6 and 18 15·0	22 56·6	over 25	Real P may be masked by micros. The phase at 17h 38·8m may suggest a dual earthquake.
1895	" 8			0 49·8 1 01·9	1 04·5	1 45·4?	0·3	Distant. Gradual thickening.
1896	" 8			6 25·5 6 27·9	6 28·1	6 59·3	0·3	Gradual thickening.
1897	" 12			18 26·3 18 28·3	18 28·7	19 11·3?	0·2	
1898	" 14		17 26·1	17 42·1 17 48·0	17 55·9	19 16·5	0·3	Micros before 17h 21·4m. Distant eq.
1899	" 16			14 11·2 14 16·7	14 18·5	14 41·9	0·3	
1900	" 22			10 34·7 11 18·6	11 19·7	11 48·9?	0·2	Micros going on.
1901	" 29		12 30·2?	12 44·1 12 56·9	12 57·5	13 30·4?	0·3	Distant.
1902	" 30	13 45·0?	13 53·7	14 02·0	14 16·5	Micros.	0·6	Time of P very doubtful, micros going on.
1903	" 30			18 52·8 18 56·6	19 02·4	21 13·5?	2·0	May be a dual eq.

8th—Micros began at 14h. 42m. and were heavy during evening and night hours, continuing until morning of 9th.

Boom period 18 seconds. Pillar inclination 1mm. = 0″·45.

VICTORIA, B. C.

F. N. DENISON, SUPERINTENDENT.

No.	Date 1918	P.T. Comm.	S. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Remarks
		h m s	h m s	h m s	h m s	h m s	mm	
1890	Sept. 2	14 57 22?			15 07 42	15 21 28?	0·2	
1891	" 5				12 30 56		0·1	
1892	" 7	17 23 38	17 26 02	17 33 28	17 53 08	22 29 32	30·0	1,360 km.
1893	" 8	00 11 56?			00 50 07	01 20 50	0·2	P. may be L. phase. Probably after shocks from above.
1894	" 8	06 03 00		06 14 30	06 21 30	07 01 00	0·2	" " "
1895	" 8			22 27 37?) 22 42 30)	22 56 08	00 33 31	0·2	" " "
1896	" 9			00 01 05?		00 04 05?	0·2	" " "
1897	" 12				13 51 31		0·1	" " "
1898	" 12	18 08 15		18 10 43	18 12 11	18 22 01	0·2	1,410 km. Alaska.?
1899	" 14	17 21 17	17 25 43	17 37 01	17 44 53	18 38 00	0·5	2,770 km.
1900	" 15				6 13 29?		0·05	
1901	" 16	14 01 49?			14 12 38	14 23 57	0·2	
1902	" 22	10 58 51	11 01 49	11 07 43	11 12 08	11 29 50	0·2	1,720 km.
1903	" 28	10 56 30			10 59 27	11 03 24	0·1	
1904	" 29			12 50 21) 12 57 03)	13 06 54	13 30 30	0·5	
1905	" 30	13 31 33	13 34 30	13 39 25	13 55 39	14 54 10	0·6	1,710 km.
1906	" 30	18 04 32	18 08 57	18 15 31	18 47 18		1·0	2,760 km.
1907	" 30			19 15 50	19 40 55	20 42 23?	1·5	P. and S. probably masked by F of previous earthquake.

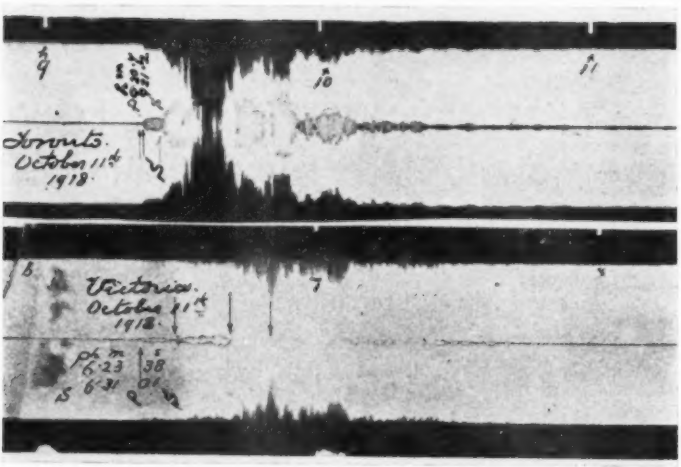
8th—Micros going on from 21h. 20m. to 0h. 40m.

9th—Local tremor felt in parts of city at 12.30, duration 1 sec. accompanied by rumbling noise. Not recorded.

Boom period 18 seconds. Pillar inclination 1mm. = 0″·54

VERTICAL SEISMOGRAPH

Date 1918	P.T. Comm.	S. Comm.	L.W. Comm.	Max.	End	Max. Amp.	Remarks
	h m s	h m s	h m s	h m s	h m s	μ	
Sept. 7	17 23 30	17 26 00	?	17 42 00	?	34	Lines crossed at time of quake. 1,430 km.



RECORDS AT TORONTO AND VICTORIA, B.C., OF THE EARTHQUAKE NEAR PORTO RICO OCTOBER 11, 1918

PORTO RICO EARTHQUAKE

The above are copies of the Seismograms at Toronto and Victoria of the earthquake which caused so much damage and was attended by a tidal wave. The earthquake was of submarine origin and the epicentre was approximately Lat. 18° 30′ N., Long. 67° 30′ West.

The Associated Press despatch says :—"San Juan P.R. One hundred and fifty persons were lost by Friday's earthquake in Porto Rico. Almost every town in the island reports damaged property and scattering fatalities.

There are unconfirmed reports here of great damage in Santo Domingo from the earthquake. The seismic shocks were followed by a tidal wave.

Reports from Aguadillo, a town on the low-lying north-western coast, say that the tidal waters half submerged the town.

Fourteen persons were killed and forty or more injured. At Ponce, a city of more than 200,000 persons on the south coast, the city hall was wrecked. The city of Mayaguez, the third largest in the island, virtually was destroyed by the inrush of water. Serious damage with probable loss of life is indicated by reports from other towns."

Later despatches say :—"There are more than 1,000 persons dead and thousands without shelter, food, or clothing as a result of the earthquake which shook the entire island. Property damaged is estimated at $5,000,000. Cable communication between the Island and Cuba was interrupted by the earthquake."

J. Y.

ASTRONOMICAL NOTES

A NINTH NOVA IN THE ANDROMEDA NEBULA.—The photographs of the Andromeda Nebula made by Professor Ritchey on February 9th and February 10th, 1918, show a faint Nova in the following approximate position with respect to the nucleus :

$$\Delta\alpha = + 440''$$
$$\Delta\delta = + 330''$$

It is in an island of faint nebulosity in one of the dark rifts of the nebula.

The magnitude on February 9th was about 17·2 and on February 10th about 17·5.

The star does not appear on any other photograph of the nebula made at this observatory ; the last preceding photograph was made January 15th, 1918, and the next following one was made July 6th, 1918. It is the ninth nova to be found in this nebula. The eighth was discovered by Professor Ritchey on the first of the two plates on which the ninth appears.—JOHN C. DUNCAN, *Publications Astronomical Society of the Pacific*, No. 176.

TOTAL SOLAR ECLIPSES OF THE NEAR FUTURE.—The total solar eclipse of May 29, 1919, will no doubt attract several observers if the international conditions are not too serious. The shadow path will cross centrally over South America, the Atlantic Ocean and Africa. The total phase will begin at sunrise off the coast of Northern Chile at longitude + 75° W. and latitude 20° S. It will pass over Tacna in Chile, La Paz in Bolivia, over Brazil, and emerge from South America at longitude 39° W., latitude 3° S. It will pass over the St. Paul Rocks, a few hundred miles northeast of the coast of Brazil, over Princes Island near the Congo coast of Africa, enter the African

coast in longitude 9° E., latitude 1° N., and terminate at sunset at a point between the north end of Madagascar and the mainland of Africa. The eclipse duration is of unusual length. The total phase will last 6 minutes 50 seconds in the mid-Atlantic Ocean. The duration on the coast of Brazil is about 5 minutes 25 seconds, and on the west coast of Africa about 5 minutes 8 seconds. I have seen no data as to prevailing weather conditions along the line of totality, but they are probably unpromising except in Chile and Bolivia; and there, unfortunately, the eclipse occurs so soon after sunrise, that results of great value could scarcely be expected. The Lick Observatory will not plan to observe this eclipse.

The total solar eclipse of October 1, 1921, will occur in the antarctic regions of the earth, and it can scarcely be called observable.

In the total solar eclipse of September 21, 1922, the shadow will cross the Indian Ocean, the northern part of Australia, and thence proceed easterly a short distance into the Pacific Ocean. It would seem that fairly promising weather conditions may be found in Australia.

The total solar eclipse of September 10, 1923, should find good observing conditions. No doubt it will be extensively observed if political conditions are fairly well settled. Oppolzer's eclipse charts have the shadow entering the United States at about the centre of the Californian coast line and then proceeding south-easterly, but this is probably an error due to the imperfect method used in charting the eclipse paths. Professor Todd has computed the eclipse path (*Popular Astronomy*, XXI., p. 352, 1913), and he finds that the central line of totality will enter the west coast of the peninsula of Lower California at latitude about 32° N., will pass close to Zacatecas, and will enter the Gulf of Mexico a short distance south of Tampico. The duration in Central Mexico will be nearly four minutes. The central line of the shadow, according to Professor Todd's computations, will lie six or eight miles southwest of San Nicolas

Island, which is situated about one hundred miles southwest of Los Angeles. This island is possibly four by eight miles in size. Its September climate is probably excellent, but the transport and living problems might be difficult. The observing conditions at many points along the line in Mexico should be fine.

The solar eclipse of January 24, 1925, will be total in the north-eastern part of the United States. It will occur in the early forenoon. To the best of my knowledge, the detailed computations have not been made. The exact localities to be visited by the shadow are not yet known.—W. W. CAMPBELL, *Publications Astronomical Society of the Pacific*. No. 176.

RELATION OF LIGHT TO HEALTH.—On the whole, the relation of light to health may be summarised, in view of the few data submitted, by the statement that it is intimately bound up with the perpetuation of life, whether the tissues be normal or diseased. It tends to sustain health by promoting, as radiant energy, the activity of the oxidising ferment adrenozidase, which sustains the oxidation of tissue cells, an essential function of their life. It tends to defend the cells, when endangered by certain germs and poisons, by enhancing through the heat energy developed the efficiency of the defensive ferments which submit these harmful agencies to digestive destruction.—C. E. DE M. SAJOUS, *English Mechanic and World of Science*, October, 18, 1918.

MARS.—We used at one time to hear something of the wonderful eyesight and the months of practice necessary to enable an observer to see the canals of Mars. That is all nonsense. Given the proper conditions, almost anyone can see the coarser canals at the first glance, and after five or ten minutes study, will see most of the fainter ones. There is nothing superhuman about it all. There are of course such things as poor eyes and good eyes, but good eyes are all just about alike, and there is very little difference between them. If one can see the Mare

Frigoris on the Moon with the naked eye or through spectacles, one can see the canals of Mars. The main differences in the drawings of Mars made by various observers, I take it, is not caused by differences in what they see—we all see alike,—but rather by differences in the manner of representing what they see.

On an average night finer planetary detail can certainly be seen with an aperture of 12 inches than with one of 36 inches. I have seen some of the coarser canals clearly in Jamaica with a 3-inch aperture. By "seen" I do not mean occasionally glimpsed for a second or two, I mean held steadily and continuously as long as I chose to look at them. Surprisingly good work has been done by Dr. Lau in Denmark with an aperture of a little less than four inches. It is probable that nothing of importance has yet been discovered on Mars that cannot be well seen with a good 12-inch reflector, properly located.—W. H. PICKERING, *Publications Astronomical Society of the Pacific*, No. 177.

THE AURORA.—The fact that brilliant shifting auroras are accompanied by magnetic storms renders it practically certain that they, and presumably therefore all auroras, are due to electric discharges; and the further fact that they vary in frequency with the sunspot period indicates that this current either comes from or is induced by the sun. For some time it was thought probable that auroras are caused by negative particles shot off from the sun, and entrapped by the magnetic field of the earth. On the other hand, Vegard has given strong arguments in favor of the α particle which is positively charged, and Störmer has found at least one case that required the positive charge to account for the observed magnetic disturbance.

The evidence, then, while not conclusive, indicates that auroras are due to streams of α particles in the upper atmosphere shot off by radio-active substances in the sun.—W. J. HUMPHREY, "Physics of the Air," *Journal of the Franklin Institute*, October, 1918.

J. R. C.

NOTES AND QUERIES

Communications are Invited. Especially from Amateurs. The Editor will try to Secure Answers to Queries.

Query.

A statement by an anonymous writer is found in an old Spanish book to the effect that an eclipse of the sun was observed at or near Manila, P. I., on May 24, 1622. The Canon der Finsternisse, by Oppolzer, not being available in this corner of the world, it would be of value to have the fact of the eclipse positively proved or disproved by an astronomer.

Hoping that you will be kind enough to secure an answer to this question, through the section of Notes and Queries of the R.A.S.C., I remain,—

M. Selga (Manila, P. I.).

Answer.

In the year 1622 there were two eclipses. The first was on May 10 and was an annular eclipse. The path of central eclipse began in Long. 86° W., Lat. 14° S.; its middle point was in Long. 29° W., Lat. 13° N.; it ended in Long. 33° E., Lat. 5° N. Thus the path began in the Southern Pacific Ocean, crossed the northern portion of South America and the Atlantic Ocean and ended in East Central Africa.

The second was on November 3, and was a total eclipse. Beginning of path, Long. 33° E., Lat. 17° N.; middle, 93° E., 10° S.; end, 159° E., 8° S. The path thus began in Upper Egypt and after crossing the Indian Ocean and the northern part of Australia, ended east of New Guinea. The latter eclipse could be seen in the Philippine Islands as a partial eclipse; the former was invisible there.

On June 21, 1629, there was a total eclipse, the middle point of the path of which was in Long. 121° E., Lat. 14° N., that is in the Philippine Islands.

C. A. C.

DAYLIGHT SAVING IN CANADA.

On Sunday morning, October 27, ended the first experiment in "daylight saving" on a large scale in Canada, and I think the general opinion is that it was a decided success. Our country is so extended, both in latitude and in longitude, and the employments of our people are so diverse, that one could hardly expect such an innovation to please everyone. I have learned that in some quarters the farmers did not find the new time so suitable to their work as the old; also, those who had to deliver produce of any kind early in the morning did not approve of the change. But the "non-contents" were certainly in a small minority. The resident of town or city who worked at the bench or in the office, though working only in daylight, still found unwonted time in the evening for recreation or for carrying on the campaign for "more production." In this way there was a great saving in light and therefore in power. A recent estimate is that in the United States one-and-a-quarter million tons of coal were saved; in Canada the saving would be over 100,000 tons.

A proposal was made in the United States to continue the "daylight saving" scheme throughout the year, but I think it was wise not to do so. On drawing curves to show the times of sunrise and sunset, it will be seen that (in latitude 44°) for three months in the winter the sun rises after 7 o'clock (local mean time). Now if a person's work began at 8 a.m. and he had to rise an hour earlier, using the new time, he would have to rise a very considerable time before daybreak, and, I take it, this is not pleasing to most people. But a great many begin work before 8 a.m., and very often they must rise more than an hour earlier; "summer" time in such cases would be felt to be a hardship, and there would arise a feeling of hostility to the scheme. Moreover, the saving in artificial light for working hours 8 to 5 during the winter would not be great, and there would be no daylight left over in the evening.

The entire "daylight saving" scheme shows how strangely we are bound to the indications on the face of the clock, and though

unphilosophical, unscientific and crude, the actual trial has shown that it is workable and effective. It is well-nigh certain that we shall repeat the experiment next summer.

DEATH OF DR. L. G. PEARCE.

I am very sorry to chronicle the death of Dr. Leslie G. Pearce, of Brantford, which occurred on October 5 last. He was born on July 9, 1890, and attended the Brantford Collegiate Institute. He entered the Medical Faculty of the University of Toronto in 1909 and spent three years there. The new Toronto General Hospital was then in course of erection, and, thinking the clinical facilities at Montreal to be better then, Mr. Pearce went to McGill University, where he graduated first in all final subjects. He specialized in eye, ear, nose and throat diseases, and after a graduate course in Montreal, settled in his home town. He had a well-equipped chemical laboratory and a splendid collection of apparatus for electro-therapy. During the last two years he paid considerable attention to astronomy, and in a cubical 'dome' on the roof of the house he installed a 4-inch equatorial telescope. Being furnished with some meteorological instruments by Sir Frederic Stupart, he made daily observations from February 1, 1918, to September 28. In this JOURNAL for April of this year will be found a sketch of a halo seen at Brantford and a note on its appearance, by Dr. Pearce. I cannot here speak of the many fine traits of his character which caused him to be admired and loved by all who knew him. He was stricken with Spanish influenza on September 29, and through his anxiety to minister to others he fell a victim to pneumonia, which very suddenly proved fatal.

DEATH OF MR. ANDREW ELVINS.

Mr. Elvins died on the morning of October 28 at the age of 95. An account of his life will appear in a later issue.

C. A. C.

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